♦

Heads I Win, Tails You Lose: Uncertainty and the Protection of Biodiversity from Invasive Alien Species

Sophie Riley*

Abstract

Scientists anticipate that the problem of invasive alien species will be exacerbated by co-stressors of biodiversity, such as land clearing and climate change. One of the most effective means of regulating invasive alien species is to prevent their entry by implementing rigorous quarantine measures with strong border controls. Yet regulators face constant uncertainty, both with regard to the impact of invasive alien species on biodiversity, and also with the need to navigate a range of opinions on how best to deal with such uncertainty. These difficulties are illustrated by the differing approaches to uncertainty embodied by the World Trade Organization and the *Convention on Biological Diversity*. While the former emphasises the need for overcoming uncertainty, the latter also accommodates the need to *manage* uncertainty. This article explores the impasse resulting from these strategies and also analyses whether Australia's Weed Risk Assessment provides a potential solution. It is argued that the Weed Risk Assessment can establish 'plausible hypotheses' that channel into the precautionary approach, giving regulators the flexibility of managing uncertainty by implementing measures without the benefit of full and conclusive scientific evidence. What is not clear, however, is whether the information-based processes of the Weed Risk Assessment will satisfy the scientific certainty requirements of the World Trade Organization.

I Introduction

Towards the middle of 2010, the Australian media reported the discovery of a breeding colony of cane toads in the southern suburbs of Sydney.[1] The discovery

* Dr Sophie Riley is Senior Lecturer in Law at the University of Technology, Sydney.

1 Nicky Phillips and Eric Jensen, 'Hopalong Catastrophe: Sydney Surrenders to Northern Invaders', *Sydney Morning Herald* (online), 5 May 2010 <http://www.smh.com.au/environment/conservation/hopalong-catastrophe-sydney-surrenders-to-northern-invaders-20100504-u75m.html>; *Audio: Cane Toads in Broome and Sydney*, Australian Geographic (29 July 2010) <http://www.australiangeographic.com.au/journal/audio-cane-toads-breeding-

was unexpected. Although scientific modelling had predicted the eventual expansion of the spread of cane toads south towards Sydney and, indeed, even further south towards Victoria,[2] the toads were not projected to spread to Sydney by 2010.[3]

Cane toads were originally introduced into the Australian State of Queensland in June 1935 by the Australian Bureau of Sugar Experimental Stations ('BSES')[4] in the belief that they would control two native beetles, the french's and greyback cane beetles, which were devastating the Australian sugar industry.[5] Although not the subject of definitive studies, it is generally accepted that cane toads proved worthless in controlling the beetles,[6] instead developing into a notorious predator that progressively kills and poisons an array of Australian native animals.[7] Yet, for some 70 years after their introduction, cane toads were principally limited to the warmer regions of Northern Australia.

Once cane toads commenced expanding their range, however, attempts at halting their spread were largely ineffective. By 2002 they had reached Kakadu National Park in the Northern Territory[8] and by 2008 toads were steadily advancing southward.[9] Efforts made at predicting the range of cane toads were complicated by the fact that they were proving more adaptable than originally anticipated and were further exacerbated by higher temperatures resulting from global climate change. In particular, global warming is driving cane toads beyond original estimates.[10] Such complexities are indicative of the difficulties authorities face in designing regimes to manage invasive alien species ('IAS'), while simultaneously dealing with uncertainty.

At the international level, the environmental community has advocated the use of a precautionary approach.[11] Effectively, alien species are presumed 'guilty' unless demonstrated to be innocent. However, a presumption of guilt

---

near-sydney.htm>; NSW Government, Environment and Heritage, *Cane Toad – Key Threatening Process Listing* (28 February 2011) <http://www.environment.nsw. gov.au/determinations/ BufoMarinusKtp.htm>.

2 NSW Government, Environment and Heritage, above n 1.

3 Ibid, detailing the unanticipated discovery of cane toads on the higher slopes of the Great Dividing Range.

4 The Australian Bureau of Sugar Experimental Stations ('BSES') was formed in 1900 to enhance the profitability of the sugar cane industry: see <http://www.bses.org.au>.

5 Australian Museum, *Animal Species: Cane Toad* (6 December 2011) <http://australianmuseum.net.au/Cane-Toad/>; CSIRO, *The Cane Toad* (2003) <http://www. csiro.au/proprietaryDocuments/CSE_ctfacts.pdf>.

6 CaneToadsinOZ.com, *Debunking Myths about Cane Toad Impact* <http://www.canetoadsinoz .com/ debunkingcanetoadimpactmyths.html>.

7 NSW Government, Environment and Heritage, *Case Study – Cane Toads (*Bufo Marinus*)* (26 February 2011) <http://www.environment.nsw.gov.au/pestsweeds/PestAnimalsCaneToads.htm>; B Grace, 'Cane Toads and Top End Fish' (2008) 42 *Fishnote* 1.

8 RA Van Dam, DJ Walden and GW Begg, *A Preliminary Risk Assessment of Cane Toads in Kakadu National Park* Scientist Report 164, Supervising Scientist (2002) <http://www.environment.gov.au/ssd/publications/ ssr/pubs/ssr164.pdf>.

9 NSW Government, Environment and Heritage, above n 1, [8].

10 Ibid.

11 See discussion in part III of this article.

against alien species often encumbers regulators with making decisions before they have acquired a high degree of certainty with regard to the invasive qualities of these species[12] – a methodology that is not embraced by all international regimes. The World Trade Organization ('WTO'),[13] for example, eschews the anticipatory nature of precautionary measures and instead emphasises the need for scientific certainty;[14] hence, the WTO regards alien species as 'innocent' until proven guilty. The differing procedures endorsed by these two approaches crystallise in the evaluation processes that determine whether regulators should permit the introduction of alien species. This article explores the impasse resulting from these divergent approaches and analyses whether Australia's Weed Risk Assessment provides a potential solution.

The article commences with a review of how IAS threaten biodiversity, highlighting the uncertainty that surrounds this area of regulation. The discussion follows with an analysis of 'uncertainty' in the context of international environmental law and also within the WTO, focussing on import risk analysis as a precursor to strong border controls.

It is argued that the WTO rules are based on *overcoming* uncertainty and avoiding type I errors, that is false positive results, which indicate a species is likely to become invasive. Conversely, the precautionary approach envisages that regulators should *manage* uncertainty; and is based on averting type II errors, that is, false negative results which indicate a species is not likely to be invasive. It is further argued that where a 'plausible hypothesis' demonstrates the likelihood of a species becoming invasive, this should be sufficient to justify precautionary measures in order to avert type II errors.

The differences between the approaches of international environmental law and the WTO are starkly evident in their treatment of inconclusive evidence. In this case, the rules of the WTO amount to a 'heads I win, tails you lose' scenario that channels plentiful, though inconclusive, evidence into the risk assessment process. Yet, the very fact that the evidence is inconclusive means that it cannot form the basis of measures. The discussion concludes by evaluating Australia's Weed Risk Assessment as a possible way forward – although it is not clear whether the information-based processes of the Weed Risk Assessment will satisfy the scientific certainty requirements of the WTO.

---

[12] Richard D Horan et al, 'Biological Pollution Prevention Strategies Under Ignorance: The Case of Invasive Species' (2002) 84 *American Journal of Agricultural Economics* 1303, 1303.

[13] *Marrakesh Agreement Establishing the World Trade Organization*, opened for signature 15 April 1994, 1867 UNTS 3 (entered into force 1 January 1995) ('*Marrakesh Agreement*'). The WTO has 153 members: see <http://www.wto.org/english/thewto_e/whatis_e/tif_e/org6_e.htm>.

[14] Appellate Body Report, *European Communities – Measures Concerning Meat and Meat Products (Hormones)*, WTO Doc WT/DS/26/AB/R (16 January 1998), [123] <http://www.wto.org/english/tratop_e/dispu_e/cases_e/ ds26_e.htm> ('*EC – Hormones*').

II Biodiversity and Invasive Alien Species

Invasive alien species are alien species that threaten ecosystems, habitats or other species.[15] The threats to biodiversity posed by IAS have been extensively documented,[16] and include predation on native species,[17] modification of habitat[18] and introducing pests and diseases.[19] Each of these impacts has the potential to lead to irreversible outcomes, such as species' extinctions.[20]

---

15 Conference of the Parties of the Convention on Biological Diversity, *Report of the Sixth Meeting of the Conference of the Parties to the Convention on Biological Diversity Held in The Hague 7–19 April 2002*, UN Doc UNEP/CBD/COP/6/20 (27 May 2002), definitions in footnote 57 paras (i), (ii) <http://www.cbd.int/doc/meetings/cop/cop-06/official/cop-06-20-en.pdf> ('*COP-6 Report*').

16 Carol M Brown, 'Tilapia and the Environment' (1995) 4(2) *Ted Case Studies*, case no 208, <http://www.american.edu/TED/tilapia.htm>; E Grossman, 'Nile Perch, Trade and Environment' (1995) 4(2) *Ted Case Studies*, case no 206 <http://www.american.edu/TED/perch.htm>]; Ted Center, J Howard Frank and Allen F Dray, 'Biological Invasions: Stemming the Tide in Florida' (1995) 78(1) *Florida Entomologist* 45; Steve L Coles and L Eldredge, 'Nonindigenous Species Introductions on Coral Reefs: A Need for Information' (2002) 56 *Pacific Science* 191; Lyle Glowka, 'Bioprospecting, Alien Invasive Species, and Hydrothermal Vents: Three Emerging Legal Issues in the Conservation and Sustainable Use of Biodiversity' (2000) 13 *Tulane Environmental Law Journal* 329; Lyle Glowka and Cyril de Klemm, 'International Instrument, Processes and Non-indigenous Species Introductions – Is a Protocol Necessary?' (1996) *Environmental Policy and Law* 247; Peter Jenkins, 'Paying for Protection from Invasive Species' (2002) Fall, *Issues In Science And Technology* 67; T McDowell, 'Slow-Motion Explosion: The Global Threat of Exotic Species and the International Response to the Problem in the South Pacific' (1998) 9 *Colorado Journal Of Environmental Law and Policy* 187; Jeffrey A McNeely, 'Invasive Species: A Costly Catastrophe for Native Biodiversity' (2002) 1(2) *Land Use And Water Resources Research* 1; Anne Perrault, Anne and William Carroll Muffett, 'Turning off the Tap: A Strategy to Address International Aspects of Invasive Alien Species' (2002) 11 *Review Of European Community & International Environmental Law* 211; Jeffrey A McNeely (ed), *Global Strategy for Addressing the Problem of Invasive Alien Species* (2000) Convention on Biological Diversity <https://www.cbd.int/doc/principles/ais-strategy-gisp.pdf>; Marc Miller, 'Biological and Cultural Camouflage: The Challenges of Seeing the Harmful Invasive Species Problem and Doing Something About It' in Marc Miller and R Fabian, *Harmful Invasive Species: Legal Responses* (Environmental Law Institute, 2004); SSC Invasive Species Specialist Group, *IUCN Guidelines for the Prevention of Biodiversity Loss Caused by Alien Invasive Species* (2000) IUCN, [1] <http://intranet.iucn.org/webfiles/doc/SSC/SSCwebsite/Policy_statements/IUCN_Guidelines_for_the_Prevention_of_Biodiversity_Loss_caused_by_Alien_Invasive_Species.pdf>.

17 Brown, above n 16.

18 I Wallentinus and C D Nyberg, 'Introduced Marine Organisms as Habitat Modifiers' (2007) 55 *Marine Pollution Bulletin* 323, 325–7.

19 Clare Shine, Nattley Williams and Lothar Gündling, *A Guide to Designing Legal and Institutional Frameworks on Alien Invasive Species* (IUCN, 2000) [1.4].

20 R Wittenberg (ed), *An Inventory of Alien Species and their Threat to Biodiversity and Economy in Switzerland. CABI Bioscience Switzerland Centre to the Swiss Agency for Environment, Forests and Landscape* (2005) 26 <http://www.nobanis.org/files/invasives%20in%20CH.pdf>; K Stokes, K O'Neill and R McDonald, *Invasive Species in Ireland* (Unpublished report to Environment & Heritage Service and National Parks & Wildlife Service, Quercus, Queens University Belfast, Belfast, 2004) [1.6] <http://www.botanicgardens.ie/gspc/pdfs/quercusreport.pdf>; Environment Protection Authority, *NSW State of the Environment 1997*, [2.6]; Greg Sherley and Sarah Lowe, 'Towards a Regional Invasive Species Strategy for the South Pacific: Issues and Options' in G Sherley (ed), *Invasive species in the Pacific: A Technical Review and Draft Regional Strategy* (South Pacific Regional Environment Programme, 2000) 7–8.

Moreover, scientists anticipate that co-stressors to biodiversity, such as land clearing[21] and climate change,[22] will intensify the dangers posed by IAS. Both land clearing and changes in temperature patterns, for example, provide alien species with opportunities to expand their ranges.[23] As this occurs, so too will 'homogenization of the global biota', resulting in loss of biodiversity.[24] In central and South America, large numbers of harlequin frogs have already disappeared due to a chytrid fungus that is most active in warmer temperatures.[25] Indeed, the fact that regulators need to deal with co-stressors adds another dimension and level of complexity to IAS regulation.

As mentioned, stopping introductions of IAS is considered the most cost-effective policy.[26] Yet, in designing regimes, regulators face many challenges, not the least of which is dealing with uncertainty.[27] In the context of IAS, uncertainty stems from inconclusive or incomplete evidence with respect to the invasive qualities of a species,[28] the impact of IAS on biodiversity,[29] the best

---

21 Australian Government, *Factors Influencing Weeds* (14 September 2007) <http://www.weeds .gov.au/ weeds/why/factors.html>.

22 John Stachowicz et al, 'Linking Climate Change and Biological Invasions: Ocean Warming Facilitates Nonindigenous Species Invasions' (2002) 99 *Proceedings of the National Academy of Sciences of the United States of America* 15 497, 15 497. With respect to the impact of IAS and climate change, see Tim Low, 'Climate Change and Invasive Species: A Review of Interactions' (November 2006 Workshop Report) Department of Sustainability, Environment, Water, Population and Communities, 3, 10 <http://www.environment.gov.au/biodiversity/publications/ pubs/interactions-cc-invasive.pdf>.

23 Stachowicz et al, above n 22, 15 497; Low, above n 22, 10; Willfried Thuiller, David Richardson and Guy Midgley, 'Will Climate Change Promote Alien Plant Invasions?' (2007) 193 *Ecological Studies* 197, 197–8.

24 Stachowicz et al, above n 22, 15 497.

25 Low, above n 22, 10; see also Will Steffen et al, *Australia's Biodiversity and Climate Change (Summary for Policy Makers 2009)* (2009) Department of Climate Change and Energy Efficiency, 6 <http://www.climatechange.gov.au/~/media/publications/biodiversity/biodiversity-summary-policy-makers. ashx>, detailing threats to Kakadu National Park by the combined effects of invasive plants and animals and climate change; Tracy Benning et al, 'Interactions of Climate Change with Biological Invasions and Land Use in the Hawaiian Islands: Modeling the Fate of Endemic Birds Using a Geographic Information System'(2002) 99 *Proceedings of the National Academy of Sciences of the United States of America* 14 246, where the authors note that the Hawaiian honeycreeper is predicted to become extinct on the islands of Kauai and Hawaii as a result of the combined effects of climate change and the spread of introduced predators and diseases.

26 NSW Inter-agency Biodiversity and Climate Change Impacts and Adaptation Working Group, *NSW Biodiversity and Climate Change Adaptation Framework 2007–2008* (October 2007) <http://www.environment.nsw.gov.au/resources/threatenedspecies/0762biodivccadapt.pdf> 26.

27 L Joe Moffit, John K Stranlund and Craig D Osteen, 'Robust Detection Protocols for Uncertain Introductions of Invasive Species' (2008) 89 *Journal of Environmental Management* 293, 294; Peter Caley, W M Lonsdale and P C Pheloung, 'Quantifying Uncertainty in Predictions of Invasiveness' (2006) 8 *Biological Invasions* 277, 278; Daniel Simberloff, 'Global Climate Change and Introduced Species in United States Forests' (2000) 262 *The Science of the Total Environment* 253, 256.

28 Horan et al, above n 12, 1306; Iftikhar U Sikder, Sanchita Mal-Sarkar and Tarun K Mal, 'Knowledge-Based Risk Assessment Under Uncertainty for Species Invasion' (2006) 26 *Risk Analysis* 239, 240.

29 See generally, Kurt K Benke, Jackie L Steel and John E Weiss, 'Risk Assessment Models for Invasive Species: Uncertainty in Rankings from Multi-criteria Analysis' (2011) 13 *Biological Invasions* 239 <http://www.springerlink.com/content/68893n3488512123/fulltext.pdf>.

means of eradicating or containing IAS,[30] and uncertainty with respect to the combined impacts of IAS and co-stressors to biodiversity.[31] The regulator's task is further compounded by the need to consider strategies that traverse an array of regulatory domains.[32] In designing strong border controls, States need to take into account obligations and commitments pursuant to the *Convention on Biological Diversity* (*'CBD'*),[33] the international trade law regime[34] and the impact of these obligations on domestic quarantine systems.

Given the uncertainty that surrounds IAS regulation, an important consideration is how these domains deal with uncertainty. In particular, international law exerts powerful constraints on national action, as is evident in the tension between the ideals of global free trade and protection of the environment.[35] While the former emphasises the need for scientific certainty, the latter emphasises the need for action based on precaution in the face of scientific *uncertainty*. This difference of opinion is illustrated by the individual approaches to the regulation of IAS embodied in the *CBD*, on the one hand, and the *Agreement on the Application of Sanitary and Phytosanitary Measures* (*'SPSA'*),[36] on the other.

---

30 Mark E Eiswerth and G Cornelis van Kooten, 'Uncertainty, Economics and the Spread of Invasive Plant Species' (2002) 84 *The American Journal of Agricultural Economics* 1317, 1321.

31 Uncertainty can stem from many sources, including insufficient information, 'statistical variation, measurement error, variability … subjective judgment and disagreement': Stephen Schneider and Dristin Kuntz-Duriseti, 'Uncertainty and Climate Change Policy' in Stephen Schneider, Armin Rosencranz and John Niles (eds), *Climate Change and Policy: A Survey* (Island Press, 2002) 55; see also Rajendra Pachauri and Andy Reisinger (eds), *IPCC Fourth Assessment Report, Climate Change 2007* (Synthesis Report, IPCC, 2007) 27; Guy Midgley and Wilfried Thuiller, 'Global Environmental Change and the Uncertain Fate of Biodiversity' (2005) 167 *New Phytologist* 638, 638; Thuiller, Richardson and Midgley, 'Will Climate Change Promote Alien Plant Invasions?', above n 23, 197.

32 Moffit, Stranlund and Osteen, above n 27, 299; Congressional Budget Office, *Uncertainty in Analyzing Climate Change: Policy Implications* (2005), xiii <http://www.cbo.gov/ftpdocs /60xx/doc6061/01-24-ClimateChange.pdf>; Sikder, Mal-Sarkar and Mal, above n 28, 240.

33 *Convention on Biological Diversity*, opened for signature 5 June 1992, 1760 UNTS 79 (entered into force 29 December 1993) (*'CBD'*). There are 193 Parties to the Convention <http://www.cbd.int/convention/parties/ list/>.

34 The World Trade Organization ('WTO') has been selected for this part of the article as it is the most influential of the international trade law regimes. Not only does the WTO have a substantial membership base, but, also, where WTO members negotiate free trade agreements outside the WTO, these agreements invariably affirm existing rights and obligations under the WTO. See, for example, *Australia–US Free Trade Agreement*, signed 18 May 2004, [2005] ATS 1 (entered into force 1 January 2005) <http://www.austlii.edu.au/au/ other/dfat/treaties/2005/ 1.html>. Article 7.3 affirms the provisions of the Agreement on the Application of Sanitary and Phytosanitary Measures: see n 36 below.

35 See generally, Daniel Esty, *Greening the GATT: Trade, Environment and the Future* (Institute for International Economics, 1994); Fiona Macmillan, *WTO and the Environment* (Sweet and Maxwell, 2001).

36 Marrakesh Agreement 1867 UNTS 3 annex 1A ('Agreement on the Application of Sanitary and Phytosanitary Measures') ('SPSA'). The SPSA is a specific agreement that provides a primary source of rights and obligations for WTO members with respect to quarantine. Marrakesh Agreement 1867 UNTS 3 annex 1A ('General Agreement on Tariffs and Trade 1994') ('GATT') provides a basis of rights and obligations only where one of the more specific agreements, such as the SPSA, does not apply. See Marrakesh Agreement 1867 UNTS 3 art 1A; see also art 2.4 of

III Precaution or Scientific Certainty?

The need to exercise precaution with respect to alien species is not new. As early as 1909, the botanist Alfred Ewart said of potentially invasive plants being considered for introduction into Victoria:

> It is not too much to say that no new plant should be introduced into this State [Victoria], and not even a private garden, if there is any chance of it spreading, unless an official report on its capacities for good and evil had been obtained, and unless the report is a favourable one.[37]

It is implicit in Ewart's statement that, in exercising precaution, regulators should evaluate the invasive qualities of alien species and disallow entry to those species considered harmful or potentially harmful. This standpoint is consistent with the formulation of the precautionary approach in international environmental law, including within the *CBD*.

Parties to the *CBD* are under obligations to ensure that biodiversity is conserved and used sustainably.[38] More specifically, art 8(h) of the *CBD* requires the contracting parties to 'prevent the introduction of or control or eradicate those alien species that threaten ecosystems, habitats or species'. Detailed guidance for implementing art 8(h) is provided by the 'Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species that Threaten Ecosystems Habitats or Species' ('*CBD Guiding Principles*'), which have been adopted by the Conference of the Parties.[39] The significance of prevention is emphasised by the three-tiered regulatory approach of the *CBD Guiding Principles*, which stresses preventing introductions of IAS, followed by eradication and control measures.[40] The importance of preventative measures is further reinforced by the fact that the Principles commence with a reference to the precautionary approach, stating that decisions 'should be based on the precautionary approach … [as] … set forth in principle 15 of the 1992 *Rio Declaration on Environment and Development*'.[41]

Principle 15 of the *Rio Declaration on Environment and Development*[42] ('*Rio Declaration*') provides that: 'Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason

---

the SPSA, which stipulates that, where measures comply with the SPSA, this amounts to a presumption of compliance with, inter alia, GATT art XX(b).

37 Alfred Ewart, quoted in Tim Low, *Feral Future* (Viking, 1999) 29.

38 *CBD* art 6. Article 2 of the *CBD* defines biodiversity as the 'the variability among living organisms … and the ecological complexes of which they are part [including] diversity within species, between species and of ecosystems'.

39 *COP-6 Report* annex 1, decision VI/23, annex ('Guiding Principles for the Prevention, Introduction and Mitigation of Impacts of Alien Species that Threaten Ecosystems Habitats or Species') ('*CBD Guiding Principles*').

40 Ibid principle 2.

41 Ibid principle 1.

42 *Rio Declaration on Environment and Development*, UN GAOR, UN Doc A/CONF.151/26Rev.1 (vol 1) (12 August 1992) ('*Rio Declaration*').

for postponing cost-effective measures to prevent environmental degradation.'[43] This principle uses qualifying descriptors such as 'serious or irreversible' damage and 'full scientific certainty'. As such, principle 15 is in fact indicative of an 'approach' to be applied in cases of significant threat, rather than an overarching 'principle' guiding policy in all circumstances.

Although the approach/principle debate occupies an important place in the literature,[44] it is not the objective of this article to revisit this topic. Suffice it to say that without taking a stance on which formulation is the most appropriate, the *CBD Guiding Principles* refer to the 'precautionary approach'[45] and hence this terminology is adopted for the discussion that follows. The salient point is that states face overriding responsibilities based on notions of prevention and precaution. The trigger for measures is either the point where scientific evidence indicates that a species is a known threat to biodiversity; or where there is some evidence indicating that the species is likely to be invasive, although the evidence is incomplete or inconclusive. These commitments differ from obligations deriving from the rules of international trade law (as illustrated, for example, by the WTO), which call for scientific certainty to support measures.

The WTO commenced on 1 January 1995 in accordance with the *Marrakesh Agreement*. That Agreement also contains a set of annexures, designed to deal with technical matters, including the *SPSA*. An objective underpinning the negotiation and adoption of the *SPSA* was the desire by states to prevent quarantine measures from being used as an unnecessary restraint on international trade.[46] Accordingly, the *SPSA* is particularly relevant to the design and implementation of border controls designed to prevent the entry of IAS.[47]

---

43 Philippe Sands and Paolo Galizzi, *Documents in International Environmental Law* (Cambridge, 2003) 17.

44 For example, the *Rio Declaration* principle 15 uses the terminology 'precautionary approach' in the context of serious or irreversible environmental damage: see, for discussion, Owen McIntyre and Thomas Mosedale, 'The Precautionary Principle as a Norm of Customary International Law' (1997) 9 *Journal of Environmental Law* 221; Justice Paul Stein, 'Are Decision-makers too Cautious with the Precautionary Principle?' (2000) 17 *Environmental and Planning Law Journal* 3, 4; Cameron Hutchinson, 'International Environmental Law Attempts to be "Mutually Supportive" with International Trade Law: A Compatibility Analysis of the Cartagena Protocol to the Convention on Biological Diversity with the World Trade Organisation Agreement on the Application of Sanitary and Phytosanitary Measures' (2001) 4 *Journal of International Wildlife Law & Policy* 1, [5.3]; Henk van den Belt, 'Debating the Precautionary Principle: "Guilty until Proven Innocent" or "Innocent until Proven Guilty"?' (2003) 132 *Plant Physiology* 1122 (the latter in particular discusses the Wingspread Statement of the precautionary principle as an overarching principle that 'affirmatively states that action should be taken'); Rosie Cooney, *The Precautionary Principle in Biodiversity Conservation and Natural Resource Management: An Issues Paper for Policy-Makers, Researchers and Practitioners* (IUCN, 2004) 8; B Goldstein and R Carruth, 'The Precautionary Principle and/or Risk Assessment in World Trade Organization Decisions: A Possible Role for Risk Perception' (2004) 24 *Risk Analysis* 491, 491–2; Jacqueline Peel 'Precaution – A Matter of Principle, Approach or Process?' (2004) 5 *Melbourne Journal of International Law* 483.

45 *CBD Guiding Principles*, principle 1. Somewhat confusingly, the *CBD Guiding Principles* refer to the precautionary principle as articulated by principle 15 of the *Rio Declaration* and the preamble to the *CBD*, which are not formulated in identical terms.

46 *Punta del Este Ministerial Declaration* (1986) 25 ILM 1623 part 1 preamble and part 1 D heading 'Agriculture' (iii); Donna Roberts, 'Preliminary Assessment of the Effects of the WTO

The *SPSA* envisages that members follow a two-staged approach to their quarantine regimes, starting with the adoption of policy, followed by implementation of operational provisions. At the policy level, members need to determine and maintain a level of risk they consider appropriate, which, in the *SPSA*, is referred to as an 'appropriate level of protection' ('ALOP').[48] At the operational level, members may implement only those measures that give effect to the ALOP.[49] This constraint positions the ALOP as an upper ceiling beyond which measures cannot exceed.[50] In addition, members need to ensure that their quarantine measures either adhere to international standards[51] (as determined by bodies such as the World Organization for Animal Health ('OIE')[52] and the *International Plant Protection Convention* ('*IPPC*')[53]) or are based on a risk assessment in accordance with arts 2.2 and 5.1 of the *SPSA*.[54] Notions of

---

Agreement on Sanitary and Phytosanitary Trade Regulations' (1998) 1 *Journal of International Economic Law* 377, 380; Steve Charnovitz, 'The Supervision of Health and Biosafety Regulation by World Trade Rules' (1999–2000) 13 *Tulane Environmental Law Journal* 271, 272; Donna Roberts, 'The Integration of Economics in SPS Risk Management Policies: Issues and Challenges' in Kym Anderson, Cheryl McRae and David Wilson (eds), *The Economics of Quarantine and the SPS Agreement* (Centre for International Economic Studies Adelaide, 2001) 9, 13.

47 See art 1A of the *Marrakesh Agreement* and arts 2.4, 3.5 and 12.1 of the *SPSA*. For a discussion of the *SPSA*, see J Pauwelyn, 'The WTO Agreement and Phytosanitary (SPS) Measures as Applied in the First Three SPS Disputes' (1999) *Journal of International Economic Law* 641.

48 *SPSA* annex A art 5. Although there are no provisions in the *SPSA* that categorically declare a state must determine its ALOP, a state is expected to determine its ALOP prior to enactment of quarantine measures: see Appellate Body Report, *Australia – Measures Affecting Importation of Salmon*, WTO Doc WT/DS/18/AB/R (6 November 1998), [201] ('*Australia – Salmon*'). Moreover, the requirement to set an ALOP is implicit in the wording of several provisions in the *SPSA*, such as art 4.1, which deals with equivalence, and arts 5.4 and 5.6, which refer to the least trade-restrictive measures, all of which proceed on the assumption that an ALOP has already been set: see *Australia – Salmon* [205]. For analysis of the ALOP, see J Atik, 'The Weakest Link: Demonstrating the Inconsistency of "Appropriate Levels of Protection" in Australia – Salmon' 24 *Risk Analysis* (2004) 483; S Henson, 'The "Appropriate Level of Protection": A European Perspective' in Anderson, McRae and Wilson, above n 46, 105; Senate Rural and Regional Affairs and Transport Legislation Committee, *An Appropriate Level of Protection? The Importation of Salmon Products* (June 2000) Parliament of Australia Senate <http://202.14.81.230/senate/committee/rrat_ctte/completed_inquiries/1999-02/salmon_final/report/a01.pdf>.

49 *SPSA* art 2.2.

50 Ibid; G Stanton, 'The Multilateral Trading System and SPS Agreement' in *Quarantine and Market Access* (Forum proceedings 6–7 September 2000, Department of Agriculture & Forestry, Canberra) 73, 75–6.

51 *SPSA* art 3.2.

52 *SPSA* annex A art 3(b); *International Agreement for the Creation at Paris of an International Office for Dealing with Contagious Diseases of Animals*, adopted 25 January 1924, [1925] ATS No 15 (entered into force 12 January 1925). The organization is now known as the 'OIE' and has 178 members: see <http://www.oie.int/about-us/our-members/member-countries/>. The name of the OIE was originally the Office International des Epizooties. In May 2003 the name was changed to the World Organisation for Animal Health, with retention of the OIE acronym: see <http://www.oie.int/about-us/history/>

53 *SPSA* annex A art 3(c); *International Plant Protection Convention 1997*, adopted 17 November 1997 [2005] ATS No 23 (entered into force 2 October 2005) ('*IPPC*'). The *IPPC* has 177 parties: see <https://www.ippc.int/index.php?id=7&L=0>.

54 *SPSA* arts 2.2 and 5; *EC – Hormones*, above n 14, [123], [124], [125]. See, for discussion, Kevin Kennedy, 'Resolving International Sanitary and Phytosanitary Disputes in the WTO: Lessons and Future Directions' (2000) 55 *Food and Drug Law Journal* 81, 95; Laurent A Ruessmann,

scientific certainty are therefore embedded into WTO processes by means of international standards and/or risk assessments.[55] One concession to these obligations is found in art 5.7, which permits states to implement temporary measures where scientific evidence is 'insufficient'. This article is discussed further below.

Although both the precautionary approach and notions of scientific certainty proffer differing obligations and requirements, they also accommodate avenues for dealing with *uncertainty*.

IV Dealing with Uncertainty

The concept of uncertainty has been subject to considerable commentary and discussion,[56] yet ascribing a precise meaning to it is still problematic.[57] Its definitions and descriptions span from 'confidence just short of certainty to informed guesses or speculation.'[58] In accordance with the precautionary approach, uncertainty in IAS regulation refers to a level of scientific evidence that indicates a threat to biodiversity, although that evidence may not be fully complete or conclusive.

In a practical sense, this presents challenges for regulators, not only deriving from enacting operational provisions with sparse or inconclusive scientific evidence,[59] but also from difficulties at the policy level in determining how best to deal with incomplete or inconclusive information.[60] In the latter case, regulators have three choices: reduce the level of uncertainty, reduce the effects of uncertainty,[61] or use a combination of these methods. In practice, policy instruments recommend that decision-makers adopt regimes more closely aligned to the third alternative.[62]

'Putting the Precautionary Principle in its Place: Parameters for the Proper Application of a Precautionary Approach and the Implications for Developing States in the Light of the Doha WTO Ministerial' (2002) 17 *American University International Law Review* 905, 935–6, 937.

55 EC – Hormones, above n 14, [123], [124], [125]. See discussion in Kennedy, above n 54, 95; Ruessmann, above n 54, 935–7.

56 See generally, Silvio O Funtowicz and Jerome R Ravetz, *Uncertainty and Quality in Science for Policy* (Kluwer, 1990); W E Walker et al, 'Defining Uncertainty. A Conceptual Basis for Uncertainty Management in Model Based Decision Support' (2003) 4(1) *Integrated Assessment* 5; J P van der Sluijs, 'Uncertainty and Precaution in Environmental Management: Insights from the UPEM Conference' (2007) 22(5) *Environmental Modelling and Software* 590; Marcela Brugnach et al, 'Toward a Relational Concept of Uncertainty: About Knowing Too Little, Knowing Too Differently, and Accepting Not to Know' (2008) 13(2) *Ecology and Society* 30.

57 Brugnach et al, above n 56.

58 Schneider and Kuntz-Duriseti, above n 31, 55.

59 Midgley and Thuiller, above n 31, 638; Thuiller, Richardson and Midgley, above n 23, 197.

60 See, eg, M Webster et al, 'Uncertainty Analysis of Climate Change and Policy Response' (MIT Joint Program on the Science and Policy of Global Change, Report No 95, December 2002) 1–2 <http://18.7.29.232/bitstream/handle/1721.1/3552/MITJPSPGC_Rpt95.pdf?sequence=1>.

61 Schneider and Kuntz-Duriseti, above n 31, 55.

62 Department of Environment and Climate Change NSW, *Adaptation Strategy for Climate Change Impacts on Biodiversity* (December 2007) NSW Government Environment & Heritage, 25–6 <http://www.environment.nsw.gov.au/resources/threatenedspecies/0765adaptstrat.pdf>; Congressional Budget Office, above n 32.

The first choice aims at reducing uncertainty through research, data collection and modelling.[63] The objective is to transcend the uncertainty and make 'known the unknown'.[64] For example, regulators can collect data and use modelling to predict the invasive qualities of species, their potential ranges[65] and their interaction with other stressors to biodiversity.[66] In Australia, for example, the Australian Scientific and Industrial Research Organisation (CSIRO)[67] is developing a model to map the expected change in distribution of weeds due to climate change;[68] and in Hawaii scientists are using geographic information systems to predict the relationship between climate change and invasive species.[69] The notion that uncertainty can be overcome underpins the scientific certainty requirements of the *SPSA*.[70] Consequently, WTO members need to adduce a sufficiently high level of scientific evidence to justify their quarantine measures.[71]

Yet, in general, the notion that techniques of research and modelling can fully overcome uncertainty has limitations. To start with, modelling techniques 'do not always consider all variables'[72] and, consequently, tend to capture linkages and relationships somewhat inconsistently.[73] Modelling related to IAS, for example, may not adequately take into account lag times. Studies indicate that it is not unusual for species to manifest invasive qualities an average of 147 years after their introduction,[74] with some reports increasing this figure to 170 years.[75] In a similar vein, co-stressors of biodiversity — for example, greenhouse gases already present in the atmosphere — will continue to contribute to climate change and have a cascading effect on the control of IAS for many decades to come.[76]

Another difficulty stems from the 'transient' nature of environmental problems.[77] Ecosystems are not static and stressors such as land clearing and climate change will add to the shifting dynamics within ecosystems and of ecosystems themselves.[78] Where these changes are so great that it is not possible

---

63 Schneider and Kuntz-Duriseti, above n 31, 55.

64 Ibid.

65 For a discussion of the various models, see Sikder, Mal-Sarkar and Mal, above n 28, 240–3; Jonathan Jeschke and David Strayer, 'Usefulness of Bioclimatic Models for Studying Climate Change and Invasive Species' (2008) 1134 *Annals of the New York Academy of Sciences* 1, 1, 8, 10–11; Congressional Budget Office, above n 32, 25.

66 Jeschke and Strayer, above n 65.

67 The CSIRO leads Australia in scientific and industrial research in areas as diverse as preventative health, sustainable agriculture and mineral resources: see <http://www.csiro.au/>.

68 Land & Water Australia, *Defeating the Weed Menace R&D Project*, Australian Government <http://lwa.gov.au/programs/defeating-weed-menace>.

69 Tracy Benning et al, above n 25, 14 249.

70 See discussion in part 5 of this article.

71 See discussion in part 5 of this article.

72 Tim Low, above n 22, 37.

73 Congressional Budget Office, above n 32, 2.

74 Wittenberg, above n 20, 26.

75 Low, above n 37, 216–17.

76 Congressional Budget Office, above n 32, 25.

77 Steffen et al, above n 25, 6; Congressional Budget Office, above n 32, 2.

78 Thuiller, Richardson and Midgley, above n 23, 199; Steffen et al, above n 25, 6; Congressional Budget Office, above n 32, 2.

to predict results, carrying out additional studies and modelling will not overcome uncertainty;[79] at best it will amass copious amounts of inconclusive data that requires constant monitoring and updating. Consequently, the use of modelling techniques, research and study can diminish uncertainty, but is unlikely to eliminate it.[80]

This assertion, however, does not indicate that devoting effort towards scientific certainty should be abandoned. Rather, regulators should adopt more flexible management practices that acknowledge uncertainty and incorporate it into regimes. Hence the importance of the second and third regulatory alternatives: managing the uncertainty.[81]

The precautionary approach represents a way of managing uncertainty that in international environmental law is a well-accepted premise, including in the field of IAS regulation.[82] However, regulators still need to identify an appropriately compelling threshold of significant or serious threat to the environment in order to trigger the application of measures. Although determining this threshold requires a degree of scientific certainty, the formulation of the precautionary approach does not rely on overcoming the uncertainty. To the contrary, the function of the precautionary approach is to permit measures, even though available scientific evidence is not sufficiently certain or conclusive.

In the international arena, the differences between overcoming uncertainty and managing uncertainty unfurl as two distinct strategies that regulators struggle to balance. Considered from a trade-related perspective, the problem of uncertainty flows from the need to prevent states using alien species to create unnecessary trade barriers and, in particular, to stop states asserting that lack of knowledge or inconclusive knowledge should permit them to implement measures that are more trade restrictive than required. From an environmental perspective, the problem emanates from the concern that regulators should be at liberty to prevent entry of potentially invasive species, even in the absence of conclusive scientific certainty as to the invasive qualities of these species. If the threshold is set too low, it can result in 'false positives' or type I errors, leading to implementation of unnecessary, and perhaps costly, measures.[83] If the bar is set too high, it can result in 'false negatives' or type II errors, and the introduction of potentially invasive species with calamitous consequences for biodiversity.

---

79 Brugnach et al, above n 56.

80 Congressional Budget Office, above n 32, 25.

81 Steffen et al, above n 25, 15; Paul Baer and James Risbey, 'Uncertainty and Assessment of the Issues Posed by an Urgent Climate Change. An Editorial Comment' (2009) 92 *Climatic Change* 31, 31; Brugnach et al, above n 56, 30.

82 See, eg, discussion in part 3 of this article regarding *CBD Guiding Principles* principle 1 and *Rio Declaration* principle 15.

83 Baer and Risbey, above n 81, 33.

Acknowledging that the same problem can be framed in different ways has been described as taking a 'relational approach' to uncertainty.[84] In other words, regulators observe uncertainty from the numerous and contradictory ways that the problem presents itself.[85] In the midst of competing views, regulators should take uncertainty into account in a wider context that incorporates the objectives of each regime.[86] Instead of the problem of IAS being viewed as a trade *or* an environmental problem, it should be viewed as a trade *and* an environmental problem. Since WTO processes are based on reducing uncertainty, while the *CBD Guiding Principles* favour reducing the effects of uncertainty, taking a relational approach means that regulators need to concede that 'solutions do not exclusively consist of eliminating or reducing uncertainty'.[87]

Yet, either way, regulators still need to rely on scientific evidence to determine when to implement measures and what type of measures to initiate. A suggested method lies in identifying patterns that indicate a causal link between stressors to biodiversity and resultant threats or harm to biodiversity — a concept expressed as a 'plausible hypothesis'.[88]

The concept of 'plausibility' describes a proposition that remains persuasive until an alternative is shown to be more credible.[89] This formulation draws on the work of the ancient philosopher Carneades,[90] who stated that plausibility commences with the proposition that, what appears to be true is tentatively true if it is contextually consistent with 'other things that appear to be true'.[91] As a means of dealing with uncertainty, 'plausibility' affords the following guidelines:[92] that regulators may invoke notions of plausibility where it is not possible to determine the actual state of affairs with certainty; that a statement is not plausible if it contradicts a known state of affairs; and that, in the absence of a known state of affairs, two contradictory statements may still be plausible.[93] In order to determine whether statements contradict a known state of affairs, or whether more credible propositions can apply, plausible hypotheses will need to be tested with alternatives and probabilities.[94] The significance of plausible hypotheses is that their application is not dependent on the person

84 See generally, Brugnach et al, above n 56.
85 Ibid 35, 38.
86 Ibid 41.
87 Ibid 30.
88 Simberloff, above n 27, 256.
89 Douglas N Walton, 'Abductive, Presumptive and Plausible Arguments' (2001) 21(2) *Informal Logic* 141, 149.
90 Carneades was a Greek philosopher who lived approximately 213–128 BC; see discussion in Walton, above n 89, 152–3.
91 Walton, above n 89, 152.
92 See, eg, Joseph Margolis, 'Robust Relativism' (1976) 35(1) *Journal of Aesthetics and Art Criticism* 37; Joseph Margolis, 'Plain Talk About Interpretation on a Relativistic Model' (1995) 53(1) *Journal of Aesthetics and Art Criticism* 53; Dennis Dutton, 'Plausibility and Aesthetic Interpretation' (1977) 7 *Canadian Journal of Philosophy* 327.
93 See generally, Dutton, above n 92.
94 Roger Jones, 'Managing Uncertainty in Climate Change Projections – Issues for Impact Assessment' (2000) 45 *Climatic Change* 403, 415.

knowing or believing something to be true, but instead is 'a guide to action'.[95] In essence, by creating a presumption that applies until evidence is adduced to the contrary, 'plausibility' pinpoints the stage where the precautionary approach can become operational.[96]

By way of example, these reference points can be applied to uncertainty in IAS regulation in accordance with the work of Simberloff.[97] Simberloff has noted that, notwithstanding the sparsity and inconclusiveness of scientific studies and knowledge with respect to IAS and co-stressors such as climate change, 'plausible hypotheses' single out climate change as being a significant driver of loss of biodiversity.[98] He emphasises, for example, that geographic ranges of species are already known to be dependent on climate patterns,[99] thus establishing a link between climate change and the spread of species, including alien species. Once this link is established, a review of existing data on alien species, their invasive potential and their impacts on biodiversity makes it plausible that climate change will escalate invasion rates and increase threats to biodiversity. As a plausible hypothesis, this can channel into the precautionary approach, giving regulators the option of considering remedial measures, even if they do not have sufficient evidence to claim 'scientific certainty'.

The question, however, is whether taking this course of action will lead to successful challenges against the legitimacy of measures within the WTO.

V Heads I Win, Tails You Lose: Uncertainty and the Legitimacy of Measures

In accordance with the rules of the WTO, states can demonstrate that their measures are underpinned by scientific certainty, either by using international standards or by undertaking their own 'risk assessment'.[100] The content and scope of these processes are set out in arts 2.2 and 5 of the *SPSA*[101] and have also been considered in a number of WTO decisions including *European Communities – Measures Concerning Meat and Meat Products (Hormones)* ('*EC – Hormones*')[102] and *Japan – Measures Affecting the Importation of Apples* ('*Japan – Apples*').[103]

---

95 Walton, above n 89, 153.

96 The concept of plausibility also feeds into the use of null hypotheses, discussed in part 7 of this article.

97 Simberloff, above n 27, 256.

98 Ibid.

99 Ibid 257.

100 Defined in *SPSA* annex A(4).

101 See, eg, *SPSA* art 5.1, which obliges parties to carry out a risk assessment; see also *SPSA* arts 5.2 and 5.3, which provide guidance to states on the types of matters to be taken into account in a risk assessment, as well as the choice of measures to manage the risk.

102 *EC – Hormones*, above n 14.

103 Appellate Body Report, *Japan – Measures Affecting the Importation of Apples*, WTO Doc WT/DS245/AB/R (26 November 2003), [196] ('*Japan – Apples*'); see also Appellate Body Report, *Japan – Measures Affecting Agricultural Products*, WTO Doc WT/DS76/AB/R (22 February1999), [72]–[94] ('*Japan – Agricultural'*); *Australia – Salmon*, above n 48, [121].

If a state has not based its measures on international standards, or carried out *any*, or any *proper,* risk assessment, this constitutes a breach of art 5.1 of the *SPSA*, leading to the measures being declared invalid.[104] Regulators need to be cognisant of two issues that warrant more detailed examination: the degree of certainty of the scientific evidence and the sufficiency of the scientific evidence.

A Scientific Certainty — How Certain Must the Science Be?

As already discussed, in accordance with WTO rules, a state cannot exceed its ALOP when implementing quarantine measures. Consequently, whether a state uses international standards or a risk assessment, each of these methods should identify, evaluate and differentiate between risks that breach a state's ALOP and those that do not. This means that the evaluation process needs to be precise enough and to contain scientific evidence that is certain enough to distinguish between different levels of risk.

For example, the International Standards for Phytosanitary Measures (ISPM) number 11 developed by the IPPC[105] provides that states need to identify and assess each pest for its potential to establish, spread and cause damage.[106] Similarly, in animal quarantine, the OIE's *Aquatic Animal Health Code 2009* specifies that regulators should identify and evaluate each 'hazard' or pathogen that could produce adverse consequences.[107] A comparable approach is taken with respect to risk assessments which the WTO Appellate Body has held should identify specific pests and diseases and the biological and economic consequences associated with the entry, establishment or spread of each pest and disease.[108] These stipulations require a demanding level of knowledge to support measures and are reinforced by two findings from the decision in *EC – Hormones*.

---

104 *Australia – Salmon*, above n 48, [136]. As a preliminary issue, the Appellate Body has confirmed that a risk assessment is needed for measures that were enacted before the entry into force of the *SPSA*: *EC – Hormones*, above n 14, [126]–[130]. At [128] the Appellate Body stated: 'Unlike the GATT 1947, the WTO Agreement was accepted definitively by Members, and therefore, there are no longer "existing legislation" exceptions (so-called "grandfather rights")'. However, the Appellate Body acknowledged that there would be many pre-1995 measures in existence for which no risk assessment had been undertaken and that this could impose burdens on members. In this regard, the Appellate Body pointed out that *SPSA* art 5.1 refers to risk assessment being undertaken 'as appropriate to the circumstances'. This could indicate that the Appellate Body is likely to be more accommodating with respect to pre-1995 measures, but, as it did not elaborate on what 'appropriate in the circumstances' meant, this issue is still open to debate. See, generally, *EC – Hormones* [129]–[130].

105 Secretariat of the International Plant Protection Convention, International Standards for Phytosanitary Measures, *ISPM No 11, Pest Risk Analysis for Quarantine Pests Including Analysis of Environmental Risks and Living Modified Organisms* (2004) <http://agriculture.gouv.fr/IMG/pdf/ispm_11_version_2004ang.pdf>.

106 Ibid s 2 ('Stage 2: Pest Risk Assessment').

107 OIE, *Aquatic Animal Health Code* (13th ed, 2010) ch 2.2 ('Import Risk Analysis') and, in particular, art 2.2.4, setting out the steps for risk assessment <http://www.oie.int /doc/ged/D7821.PDF>.

108 *Australia – Salmon*, above n 48, [121]; *Japan – Apples*, above n 103, [196].

The *EC – Hormones* dispute arose out of a ban imposed by the European Communities (EC)[109] on beef imported from the US that had been grown using hormones. The first finding concerned the need to evaluate the type of hormones used. The EC had supported its import ban based on a risk assessment that contained general evaluations of the carcinogenic potential of hormones in meat, but without analysis of particular hormones. The Appellate Body held that this lack of detail was insufficient to underpin an import ban.[110] The EC should have included an analysis of the carcinogenic potential of the specific hormones in question, together with a further analysis of their impact, as residues in meat derived from cattle which had been fed the hormones.[111]

The second finding involved the need to evaluate any potential misuse in the administration of the hormones. In the original determination, the Panel[112] had perused two reports that the EC commissioned in the 1980s:[113] the 1982 and 1987 Lamming Reports.[114] These reports indicated that, while the incidence of cancer from hormone use might be low, this was dependent upon the exercise of 'good agricultural/animal husbandry practice'.[115] The EC had argued that it was not possible to police whether good practices had been followed and, consequently, these assessments did not take into consideration the potential for misuse of the hormone by those administering it to the animals.[116] On appeal, the Appellate Body indicated that the EC should have conducted a risk assessment on this point.[117] However, the difficulty in carrying out such an assessment lies in the difficulty science would have in predicting the extent of potential misuse.[118] At least one study indicates that 'quantitative assessments [of potential misuse] could vary by as much as eight orders of magnitude'.[119]

For these reasons, evaluations conducted in accordance with either international standards or risk assessments involve very detailed studies,

---

109 'The European Communities' is the name given collectively within the WTO to the European Union (EU) and its 27 member states. The EU was created by the *Treaty on European Union*, opened for signature 7 February 1992, [2009] OJ C 115/13 (entered into force 1 November 1993) ('*Maastricht Treaty*'). The European Union has 27 members: see <http://europa.eu/about-eu/basic-information/index_en.htm>.

110 *EC – Hormones*, above n 14, [206]–[208].

111 Ibid.

112 Panel Report, *EC Measures Concerning Meat and Meat Products (Hormones) Complaint by Canada*, WTO Doc WT/DS48/R/CAN (18 August 1997); Panel Report, *EC Measures Concerning Meat and Meat Products (Hormones) Complaint by the United States*, WTO Doc WT/DS26/R/USA (18 August 1997).

113 Panel Report, *EC Measures Concerning Meat and Meat Products (Hormones) Complaint by the United States*, WTO Doc WT/DS26/R/USA (18 August 1997) [II(4)], [IV(2)(e)], [IV(2)(v)].

114 *EC – Hormones*, above n 14, [IV128]–[IV137].

115 Ibid, [IV129].

116 See discussion in Charnovitz, above n 46.

117 *EC – Hormones*, above n 14, [187], [206]–[209].

118 Vern R Walker, 'The Myth of Science as a "Neutral Arbiter" for Triggering Precautions' (2003) 26 *Boston College International and Comparative Law Review* 197, 206–7.

119 Mike Nunn, 'Quarantine Risk Analysis' (1997) 41 *Australian Journal of Agricultural and Resource Economics* 572.

supported by large volumes of conclusive information.[120] In both a practical and a legal sense, the requirements also affirm a high threshold for compliance.[121] In the case of IAS, this requirement means that states need to provide analyses of the invasive qualities of every IAS in question, including related information concerning the combined impacts of co-stressors to biodiversity. Given that few studies have examined the combined effects of IAS and co-stressors,[122] these requirements pose significant hurdles to adopting policy and designing regimes in a preventative manner.

The overwhelming degree of detail and certainty demanded by WTO processes is further demonstrated by considering an import request, made in 2000, from the Philippine government to the Australian government to export bananas to Australia.[123] The case raises important issues with respect to the introduction of potential IAS across international boundaries. It also demonstrates the complexity of the issues which, in this case, were so involved that the risk analysis process spanned almost a decade and generated four draft Import Risk Analysis ('IRA') reports,[124] a final IRA report[125] and two Senate Inquiries.[126] Eventually, on 3 March 2009, Biosecurity Australia[127] released a

---

120 Digby Gascoine, 'WTO Dispute Settlement: Lessons Learned from the Salmon Case' (Paper presented at 'Managing Globalisation for Prosperity', Conference on International Trade Education and Research, Melbourne, 26–27 October 2000), 10 <http://www.apec.org.au/docs/gascoine.PDF>; Charnovitz, above n 46, 290.

121 See *Australia – Salmon*, above n 48, [112]–[115]; David G Victor, 'The Sanitary and Phytosanitary Agreement of the World Trade Organization: An Assessment After Five Years' (2000) 32 *International Law and Politics* 865, 907. An example is provided by the third draft import risk analysis prepared by Biosecurity Australia, *Revised Draft Import Risk Analysis Report for the Importation of Cavendish Bananas from the Philippines*, released in three volumes and covering more than 500 pages, below n 124.

122 Thuiller, Richardson and Midgley, above n 23, 197.

123 Australian Quarantine and Inspection Service, Department of Agriculture Fisheries and Forestry, *Import Risk Analysis – Bananas From the Philippines* (Plant Quarantine Policy Memorandum 2000/10, 28 June 2000) <http://www.daff.gov.au/__data/assets/pdf_file/0014/22901/2000-10.pdf>.

124 Biosecurity Australia, *Importation of Fresh Bananas from the Philippines* (Draft IRA Report, June 2002) <http://www.daff.gov.au/__data/assets/pdf_file/0012/164001/draft-ira.pdf>; Biosecurity Australia, *Importation of Fresh Bananas from the Philippines* (Draft IRA Report, February 2004) <http://www.daff.gov.au/__data/assets/pdf_file/0006/22866/banana_rev_draft.pdf>; Biosecurity Australia, *Revised Draft Import Analysis Report for the Importation of Cavendish Bananas from the Philippines* (2007), released in parts A, B and C: <http://www.daff.gov.au/__data/assets/pdf_file/0005/157964/2007-06a.pdf>, <http://www.daff.gov.au/__data/assets/pdf_file/0006/157965/2007-06b.pdf> and <http://www.daff.gov.au/__data/assets/pdf_file/0007/157966/2007-06c.pdf> respectively.

125 Biosecurity Australia, *Final Import Analysis Report for the Importation of Cavendish Bananas from the Philippines* (2008), released in parts A, B and C: <http://www.daff.gov.au/__data/assets/pdf_file/0005/886406/PART_A_-_FINAL_-_COLOUR_COVER_AND_B-W_REST_-_PLEASE_DONT_TOU.pdf>, <http://www.daff.gov.au/__data/assets/pdf_file/0007/886408/PART_B_-_FINAL_-_COLOUR_COVER_AND_B-W_REST_-_John_081106.pdf> and <http://www.daff.gov.au/__data/assets/pdf_file/0008/886409/PART_C_-_FINAL_-_COLOUR_COVER_ AND_B-W_REST_-_John_081106.pdf> respectively.

126 Senate Standing Committee on Rural and Regional Affairs and Transport, Parliament of Australia, *Administration of Biosecurity Australia – Revised Draft Import Risk Analysis for Bananas from the Philippines* (2005) Parliament of Australia <http://www.aph.gov.au/binaries/senate/committee/rrat_ctte/completed_inquiries/2004-07/bananas/report/report.pdf>; Senate Rural and Regional Affairs and Transport References Committee, *Import Risk Analysis*

statement informing stakeholders that the Australian Director of Animal and Plant Quarantine had 'determined a quarantine policy for the importation of bananas from the Philippines', subject to compliance with strict import restrictions in accordance with the *Quarantine Act 1908* (Cth).[128]

The second draft IRA evaluated whether the importation of bananas could lead to the accidental introduction of IAS in breach of Australia's ALOP.[129] To determine this point, the report detailed species found in the Philippines, such as weeds, mammals, frogs, reptiles and molluscs that could accidentally be transported with the bananas.[130] It is important to keep in mind that the species evaluated by the report included species not only native to the Philippines, but also introduced into the Philippines, that could be further introduced from the Philippines to Australia.[131] Moreover, the report evaluated all known alien species, whether or not these species were currently invasive. The fact that a species is already invasive in one location makes it more likely that it will be invasive elsewhere,[132] but the reverse proposition cannot be assumed: a non-invasive alien species may become invasive in a new location.

The problem with this level of detail is that it is at least partly dependent on the depth of information amassed by the exporting state. It is not possible, for example, for the importing state to identify and assess individual species, unless the exporting state has knowledge of alien species found in its territory. Yet states have different resource levels and different priorities with respect to IAS and their environmental regimes. For example, in its 2006 report to the *CBD*,[133] the Philippines indicated that its IAS regime was inconsistent. It had not yet established a national target for controlling IAS[134] and its activities regarding IAS largely emphasised invasive plants.[135] Three years later, in 2009, the

(IRA) for the Importation of Cavendish Bananas from the Philippines (June 2009) Parliament of Australia <http://www.aph.gov.au/binaries /senate/committee/rrat_ctte/bananas/report/report.pdf>.

127 Biosecurity Australia is a government unit located within the Department of Agriculture Fisheries and Forestry ('DAFF') that carries out policy development, including determination of the level of risk Australia is prepared to accept with respect to imported goods and commodities: see generally <http://www.daff.gov.au/ba/about>.

128 Biosecurity Australia, 'Biosecurity Advice 2009/3: Biosecurity Policy Determination – Importation of Bananas from the Philippines' (3 March 2009) Department of Agriculture Fisheries and Forestry <http://www.daff.gov.au/__data/assets/pdf_file/0006/1026951/2009_03_Philippine_Banana_Determination_090303.pdf>.

129 Ibid 295–326.

130 Ibid 73, 295–326.

131 Ibid 332, where the report discusses introduced mammals and amphibians that inhabit the Philippines.

132 Rüdiger Wittenberg and M Cock (eds), *Invasive Alien Species: A Toolkit of Best Prevention and Management Practices CAB International* (Wallingford, 2001) 134. The toolkit states that one of the best indicators of a species' invasive potential is whether it is invasive in other states, especially those with similar 'ecological and climatic conditions'.

133 Republic of the Philippines, Protected Areas and Wildlife Bureau, Department of Environment and Natural Resources, *The Third Philippine National Report to the Convention on Biological Diversity* (2006) Convention on Biological Diversity <http://www.cbd.int/doc/world/ph/ph-nr-03-en.pdf>.

134 Ibid 32.

135 Ibid 76–7, 98.

Philippines acknowledged that while IAS posed an ever-increasing problem,[136] the government was still to determine management plans for addressing IAS, although consultations were being held with stakeholders with a view to drafting a national framework.[137]

The approach of the Philippines government is understandable, given the fact that all states face resource constraints and must prioritise their regulatory aims and objectives.[138] However, without information on the nature and extent of IAS located in the exporting state, it will not be possible for the importing state to evaluate with accuracy which species are likely to be introduced, which species are likely to become invasive and the impact of climate change on such species. Moreover, because the risk assessment process as conceptualised within the WTO requires a high degree of detail, even if Australia had wanted to, it could not have invoked the precautionary approach as the tipping point for implementation of measures.[139] Although the *CBD Guiding Principles* give the precautionary approach a prominent role in IAS regulation,[140] the *SPSA* does not even include a reference to either this approach or its related concept, the precautionary principle.

In *EC – Hormones* the EC had argued that the precautionary principle was an established principle of international law[141] and, hence, could be used to justify precautionary measures banning beef grown using hormones in satisfaction of the provisions of the *SPSA*.[142] The Appellate Body, however, held that it was 'less than clear' whether the precautionary principle had crystallised into a principle of customary international law.[143] Moreover, even if it had, the principle could not override the provisions of arts 5.1 and 5.2 of the *SPSA*, which require members to base their measures on a risk assessment.[144]

The Appellate Body further described the precautionary principle as an act of prudence[145] and found that, while the principle was not written into the *SPSA*, it

---

136 Republic of the Philippines, *Assessing Progress Towards the 2010 Biodiversity Target: The 4th National Report to the Convention on Biological Diversity* (2009) Convention on Biological Diversity, 20, 23–4, 34 <http://www.cbd.int/doc/world/ph/ph-nr-04-en.pdf>.

137 Ibid 94.

138 Resource constraints represent a significant hurdle to establishing adequate IAS regimes: see CBD 2003, Subsidiary Body on Scientific, Technical And Technological Advice, Note by the Executive Secretary, Invasive Alien Species: Identification of Specific Gaps and Inconsistencies in the International Regulatory Framework, UN Doc No UNEP/CBD/SBSTTA/9/INF/32 (5 November 2003) [98]; Jenkins, above n 16, 69–70.

139 Ultimately, Biosecurity Australia sidestepped this issue by concluding that frogs, other reptiles and molluscs were not pests of Cavendish bananas, but were contaminants that 'would be subject to action under existing quarantine policy for contaminants of quarantine concern': Biosecurity Australia, *Final Import Analysis Report for the Importation of Cavendish Bananas from the Philippines*, above n 125, 66.

140 *CBD Guiding Principles*, principle 1, referring to the precautionary approach.

141 *EC – Hormones*, above n 14, [121].

142 Ibid.

143 Ibid [123].

144 Ibid [123], [124], [125]. See discussion in Kennedy, above n 54, 95; Ruessmann, above n 54, 935–6, 937.

145 *EC – Hormones*, above n 14, [124]; see discussion in Peel, above n 44, 497–500.

was nevertheless reflected in a number of provisions of that Agreement, including art 5.7.[146] This finding, however, raises a further set of problematic issues relating to the notion of 'sufficiency' of scientific evidence as used in art 5.7.

B Scientific Certainty — How Sufficient Must the Science Be?

As already indicated, art 5.7 of the *SPSA* permits states to implement temporary measures in the absence of international standards or sufficient scientific evidence, although the measures must be reviewed within a reasonable time. The article represents a qualified exemption from the general proscription against measures being maintained without sufficient scientific evidence.[147] Article 5.7 specifies that:

> In cases where relevant scientific evidence is insufficient, a Member may provisionally adopt sanitary or phytosanitary measures on the basis of available pertinent information … In such circumstances, Members shall seek to obtain the additional information necessary for a more objective assessment of risk and review the sanitary or phytosanitary measure accordingly within a reasonable period of time.

The sufficiency of the scientific evidence is referred to, but not defined, in art 5.7. This is similar to the provisions of art 2.2, which prohibit states from maintaining permanent measures without sufficient scientific evidence.[148] Given that arts 5.7 and 2.2 refer to the concept of sufficiency, regulators need to consider what is meant by the word 'sufficient' and whether the quality of evidence required for permanent measures under art 2.2 differs from the standard of evidence required for provisional measures under art 5.7.

In *Japan — Agricultural*[149] and *Japan — Apples*[150] the Appellate Body held that the concept of 'sufficiency' in art 2.2 denotes a rational, or objective, relationship between a measure and the scientific evidence that depends 'upon the particular circumstances of the case including the characteristics of the measure at issue and the quality and quantity of the scientific evidence'.[151] Consequently, quarantine measures cannot be maintained pursuant to art 2.2 without a sufficient quality and quantity of scientific evidence that is

---

146 *EC – Hormones*, above n 14, [124]. The other provisions of the *SPSA* that, according to the Appellate Body, reflect the precautionary principle are the preamble and art 3.3. These provisions permit members to implement measures based on standards higher than those found in international standards, where the measures give effect to a member's ALOP. Where the measures are more stringent than those based on international standards, the measures must be scientifically justified by way of a risk assessment.

147 *Japan – Agricultural*, above n 103, [80].

148 *Japan – Apples*, above n 103, [175]–[185]. See discussion in Pauwelyn, above n 47, 641.

149 *Japan – Agricultural*, above n 103, [84]. For general discussion, see J Whitlock, 'Japan – Measures Affecting Agricultural Products: Lessons for Future SPS Disputes Agricultural Trade Disputes' (2002) 33 *Law and Policy in International Business* 741; Charnovitz, above n 46, 288; Victor, above n 121, 909–13; Oliver Landwehr, 'Decisions of the Appellate Body of the World Trade Organization Japan – Measures Affecting Agricultural Products' (1999) 10 *European Journal of International Law* 461.

150 *Japan – Apples*, above n 103, 143–68.

151 *Japan – Agricultural*, above n 103, [84], quoted with approval in *Japan – Apples*, above n 103, [162].

proportional to the severity of the measure. In other words, the more trade restrictive a measure becomes, the greater the levels of quality and quantity in scientific evidence that are needed.[152]

A somewhat different approach has been taken with respect to art 5.7. In *Japan – Apples*, Japan argued that art 5.7 could be interpreted as referring to an insufficiency of evidence, either where there was a lack of quantity of scientific evidence, or where there was a sufficient quantity, but the evidence was inconclusive or uncertain.[153] In rejecting Japan's argument, the Appellate Body said that the question to be answered is whether the evidence is sufficient to 'permit the evaluation of the likelihood of entry, establishment or spread of, in this case, fire blight by Japan'.[154] In addition, the concept of 'sufficiency' in art 5.7 incorporates the quality, or reliability, of the evidence,[155] but not necessarily its conclusiveness. The only question is whether there is enough reliable scientific information to conduct a risk assessment.

The difficulty with this approach, however, is that arguably it does not take into account those situations where evidence is plentiful and reliable, but is nevertheless inconclusive; nor does the approach grapple with problems stemming from scientific evidence that is so inconclusive as to be uncertain.[156] These issues were the subject of an amicus curiae brief[157] in *European Communities – Measures Affecting the Approval and Marketing of Biotech Products*[158] (*Biotech* case). The amicus curiae brief explored the link between inconclusiveness and uncertainty in scientific evidence:

> In this regard, uncertainty is a critical factor in determining the quality of the relevant scientific evidence. In fact, uncertainty may be thought of as a continuum ranging from zero for certain information … to high levels for information with true uncertainty or indeterminacy … when the available information cannot appropriately describe the risks to human, animal, or plant life or health because of the lack of understanding of events and processes, [then] policy-makers cannot ignore the lack of quality of the scientific evidence. [159]

---

152 Hutchinson, above n 44, [6.6.1.1].

153 *Japan – Apples*, above n 103, [175]–[185].

154 Ibid [179].

155 Ibid [185]. See 'Dispute Settlement Commentary (DSC) Japan – Measures Affecting the Importation of Apples'(April 2006), 16 <www.worldtradelaw.net>.

156 *Japan – Apples*, above n 103, [185]. See 'Dispute Settlement Commentary (DSC) Japan – Measures Affecting the Importation of Apples', 16 <www.worldtradelaw.net>.

157 The amicus curiae brief was lodged collectively by the Center for International Environmental Law (CIEL), Friends of the Earth – United States (FOE-US), Defenders of Wildlife, Institute for Agriculture and Trade Policy (IATP) and Organic Consumers Association – United States (OCA-USA) in June 2004 <http://www.ciel.org/Publications/ECBiotech_AmicusBrief_2June04.pdf>.

158 Panel Report, *European Communities – Measures Affecting the Approval and Marketing of Biotech Products*, WTO Docs WT/DS/291, WT/DS/292, WT/DS/293 (29 September 2006) World Trade Organization <http://www.wto.org/english/tratop_e/dispu_e/cases_e/ds291_e.htm> ('*Biotech* case') .

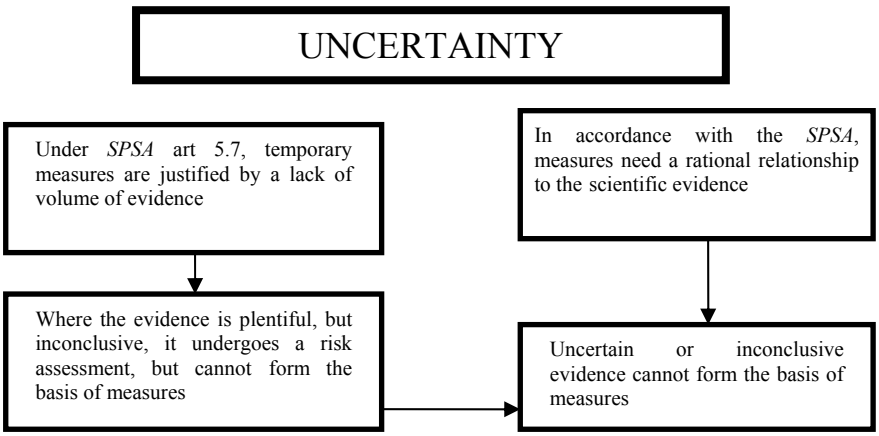
159 Amicus curiae brief, above n 157, 37.

This reasoning indicates that where scientific evidence is so inconclusive or uncertain that it cannot identify risks, it should not be used to carry out a risk assessment.[160] It is further reinforced by the fact that a high degree of uncertainty in the scientific evidence can also directly relate to the quality of the evidence. Often, states that seek to prevent entry of IAS will be faced with gaps and uncertainties in the knowledge base. As already indicated, these include uncertainty with respect to whether alien species will become invasive, uncertainty with respect to their impact on native biodiversity, and uncertainty concerning the combined impacts of IAS and other stressors of biodiversity.[161] To deny states the opportunity to implement measures where the evidence is inconclusive runs counter to the tenor of the precautionary approach, which has been formulated to guide decision-making where there is a lack of quantity of, as well as lack of conclusiveness in, the scientific evidence.

Moreover, under art 2.2 of the *SPSA*, the same level of uncertainty that prevents the implementation of provisional measures would also be considered relevant to whether there was an adequate rational, or objective, relationship between a quarantine measure and the scientific evidence. In the absence of such a relationship, the measure will not be upheld.

This last point is also directly relevant to the question whether the quality of evidence required for permanent measures under art 2.2 differs from the standard of evidence required for provisional measures under art 5.7. Permanent measures under art 2.2 require an appropriate volume of evidence that is also conclusive. However, under art 5.7, provisional measures may only be implemented in the absence of an appropriate volume of evidence, whether or not the evidence is conclusive. Figure 1 below indicates how these provisions operate in practice.

Figure 1: Uncertainty and the Agreement on the Application of Sanitary and Phytosanitary Measures



[160] Amicus curiae brief, above n 157, 36.
[161] Wittenberg and Cock, above n 132, 60.

The differing treatment given to the word 'sufficiency' means that states are expected to undertake a risk assessment where an appropriate volume of evidence exists, whether or not that evidence is conclusive. However, by pushing inconclusive evidence into the risk assessment process, it becomes impossible to justify proposed measures, because they are based on inconclusive evidence; hence they lack a rational relationship to the scientific evidence.[162] This standpoint is inconsistent with the formulation of the precautionary approach, which does not confine uncertainty to lack of quantity of scientific evidence, but also permits precautionary measures where the scientific evidence is inconclusive, although supported by preliminary evidence as, for example, in a 'plausible hypothesis'. Moreover, by not acknowledging that inconclusive evidence can also be 'insufficient', the WTO Appellate Body has steered the inquiry of scientific evidence ever deeper towards the risk assessment process. As one commentator has indicated, this can deflect a regulatory response away from uncertainty and towards perceptions of risk.[163]

VI Uncertainty or Perception of Risk

Drawing from the discussion thus far, uncertainty may be considered as a level of knowledge that is insufficient to conclude with confidence whether a species will become invasive, whether a pathway is likely to introduce IAS, and the nature of the relationship of IAS with co-stressors to biodiversity. It may stem from uncertainty in the volume, conclusiveness or agreed understanding of the scientific evidence. A perception of risk, on the other hand, may be viewed as a subjective evaluation of the degree to which a person is concerned about assessments that address whether a species will become invasive, whether a pathway is likely to introduce IAS, and the impact of co-stressors to biodiversity on those factors.[164]

Uncertainty, therefore, is based on knowledge or, more precisely, lack of knowledge, while risk depends on how much a person cares about the consequences of an event going wrong. The subjective nature of the perception of 'risk' means that it can represent different things to different people. It may be influenced by social, cultural and inter-personal factors,[165] including how risk-averse an individual is. A perception of risk may not even have a clear

[162] *Japan – Apples*, above n 103, [162]–[163].
[163] Peel, above n 44, 497–500.
[164] Lennart Sjöberg, Bjørg-Elin Moen and T Torbjørn Rundmo, *Explaining Risk Perception Rotunde* (Norwegian University of Science and Technology, 2004) [1.2]; see also R Kasperson et al, 'The Social Amplification of Risk: A Conceptual Framework' (1988) 8 *Risk Analysis* 177.
[165] Kasperson et al, above n 164, 132, 177.

connection with actual risk;[166] the latter is a calculation of the likelihood of harm occurring, rather than how one perceives the threat of that harm.[167]

Although uncertainty and perception of risk differ, they are linked, as an incomplete knowledge base or an unknown outcome can influence perceptions of risk.[168] For this reason, WTO members may only implement measures to achieve their ALOP where they are able to identify objective risks that are neither speculative, nor theoretical, nor negligible.[169] Yet, where there are gaps and uncertainties in knowledge, it may be problematic distinguishing whether a risk is speculative, theoretical or negligible – or indeed whether it will breach a state's ALOP. This is the case, even though the Panel of the WTO has held that the risk does not necessarily need to reach a certain magnitude or threshold.[170]

In *Japan — Measures Affecting the Importation of Apples, Recourse to Article 21.5* ('*Japan — Apples 21.5*')[171] the Panel examined the level of risk associated with mature symptomless apples acting as a vector for transmission of fire blight:

> The Original Panel concluded that there was not sufficient scientific evidence that apple fruit are likely to serve as a pathway for the entry, establishment or spread of fire blight within Japan. The Panel nonetheless … considered that the scientific evidence 'does suggest that some slight risk of contamination cannot be excluded.' [The current Panel therefore cannot] agree with the United States that [a negligible risk] … should be completely assimilated to a 'theoretical risk'.[172]

Although the Panel conceded that a negligible risk is not to be equated with a theoretical risk, the use of the word 'negligible' can nevertheless be ill conceived. In one sense, the likelihood of an event happening might be 'negligible', but it may not be appropriate to use the word 'negligible' to describe a low probability event if it has a high potential for damage, such as

---

166 By way of example, commentators have pointed to the fact that states' perception of the risks of genetically modified food products varies in accordance with 'differing interest groups, whose values underpin different national regulatory paradigms'. See Aynsley Kellow, Marcus Haward and Kristy Welch, 'Salmon and Fruit Salad: Australia's Response to World Trade Organization Quarantine Disputes' (2005) 40 *Australian Journal of Political Science* 17, 30.

167 Matthew JW Cock, *Biosecurity and Forests: An Introduction — With Particular Emphasis on Forest Pests* (FAO Forest Health and Biosecurity Working Paper FBS/2E, 2003) FAO, 9 <http://www.fao.org/DOCREP/006/J1467E/J1467E00.HTM>; for a short analysis from a different discipline, see K McMunigal, 'Distinguishing Risk from Harm in Conflict of Interest' (1998) 100–101 *Business and Society Review* 91.

168 Sjöberg, Moen and Rundmo, above n 164, [1.2].

169 For a discussion of this point in the context of the *Cartagena Protocol* (*Cartagena Protocol on Biosafety to the Convention on Biological Diversity*, opened for signature 29 January 2000 (entered into force 11 September 2003)), see Hutchinson, above n 44, [5.4]; *EC – Hormones*, above n 14, [186].

170 *Australia – Salmon*, above n 48, [123]–[124]. The level of risk, however, might be relevant to the choice of measures.

171 Panel Report, *Japan – Measures Affecting the Importation of Apples, Recourse to Article 21.5*, WTO Doc WT/DS245/RW (23 June 2005) ('*Japan – Apples 21.5*').

172 Ibid [8.40].

often occurs with damage caused by IAS.[173] In these instances, the word 'negligible' is seemingly used in a heuristic sense to describe the likelihood of the event happening, while glossing over matters relevant to the design of regimes, such as lack of knowledge, or lack of conclusiveness presented in the available information.

A risk-averse regulator charged with preventing entry of IAS would treat uncertainty as a reason to implement measures that minimise or prevent the entry of potentially invasive species, whereas a risk-inclined regulator would consider uncertainty as justification for not implementing measures. It is precisely for this reason that the formulation of the precautionary approach focuses on knowledge, rather than perceptions of risk.

In theory, the precautionary approach could be incorporated into a state's ALOP as a statement of policy. However, the setting of an ALOP and the consequential measures that give effect to the ALOP are exercises that need to be balanced against trade-related considerations, such as minimising negative trade impacts[174] and achieving cost-benefit justification between quarantine measures and their impact on trade.[175] Although integrating uncertainty into quarantine regimes is challenging, Australia has pioneered a process known as the Weed Risk Assessment (WRA)[176] that is specifically designed to do this.[177] Analogous processes are also being formulated for animals.[178]

---

173 D Adamson and D Cook, 'Re-examining Economic Options for Import Risk Assessments' (Paper presented at AARES Conference, Queenstown, New Zealand, 13–16 February 2007) 6 <http://www.uq.edu.au/rsmg/WP/ WPM07_3.pdf>; P Vitousek et al, 'Introduced Species: A Significant Component of Human-Caused Global Change' (1997) 21(1) *New Zealand Journal of Ecology* 1, 9.

174 *SPSA* arts 2.2 and 5.4. Article 2.2 provides that quarantine measures should only be applied 'to the extent necessary to protect human, animal or plant life or health', while art 5.4 stresses that members should take into account the objective of minimising negative trade effects.

175 *SPSA* art 5.2 provides that, when members are undertaking a risk assessment, they should take into account 'the potential damage in terms of loss of production or sales in the event of the entry, establishment or spread of a pest or disease … and the cost-effectiveness of alternative approaches to limiting risks'.

176 DAFF, *The Weed Risk Assessment System* (22 October 2008) <http://www.daff.gov.au/ba/reviews/weeds/system>. See also T Low, 'Preventing Alien Invasions. The Precautionary Principle in Practice in Weed Risk Assessment in Australia' in R Cooney and B Dickson (eds), *Biodiversity and the Precautionary Principle: Risk and Uncertainty in Conservation and Sustainable Use* (Earthscan, 2005) 141.

177 Ibid. The process is becoming popular and is being used by other states, such as Ecuador with respect to the Galapagos Islands: H Rogg, C Buddenhagen and C Causton, 'Experiences and Limitations with Pest Risk Analysis in the Galapagos Islands' in IPPC Secretariat, *Identification of Risks and Management of Invasive Alien Species Using the IPPC Framework* (2005) (Proceedings of the workshop on invasive alien species, Braunschweig, Germany, 22–26 September 2003) 120. The authors also note that the WRA has limitations because it does not assess pathways of introduction of alien species.

178 See generally, Mary Bomford, *Risk Assessment for the Import and Keeping of Exotic Vertebrates in Australia* (Bureau of Rural Sciences, 2003); Biosecurity SA, *South Australian Pest Animal Risk Assessment* (8 November 2011) <http://www.pir.sa.gov.au/biosecuritysa/nrm_biosecurity/pest_animal/sa_pest_animal_risk_assessment>; Mary Bomford, *Risk Assessment Models for Establishment of Exotic Vertebrates in Australia and New Zealand* (Invasive Animals Cooperative Research Centre, Bureau of Rural Sciences, 2008).

VII Australia's Weed Risk Assessment

The WRA is an evaluation process developed under the leadership of Paul Pheloung.[179] It calculates whether a plant is likely to become a weed in Australia[180] and can also identify whether an applicant has provided sufficient information to permit regulators to make a determination of weediness. The WRA is becoming increasingly accepted, having been adopted by other states, including New Zealand, some parts of the USA[181] and the Galapagos Islands.[182]

As used in Australia, the WRA[183] comprises 49 questions concerning the plant proposed to be imported that cover matters such as the plant's distribution,[184] whether the plant is toxic to animals,[185] whether it hybridises naturally,[186] and information about its dispersal.[187] The answers are scored,[188] and a minimum number of questions must be answered. In scoring answers, the WRA largely steers clear of weighting scores, because of difficulties in demonstrating a scientific basis for this process; however, answers from five questions are subject to weighting. These questions relate to the weediness of the plant overseas, especially in countries with similar climate conditions to Australia.[189] Weighting in these cases is considered appropriate in order to take full advantage of the classification capabilities of the system.[190]

The scores generated by the WRA identify three groupings of plants: 'permitted', 'prohibited' or 'further evaluate'.[191] The 'further evaluate' category applies either where applicants have provided insufficient information to determine weediness or where the information is inconclusive and the assessment process 'cannot clearly differentiate between a weed and non-weed'.[192] If the species requires further evaluation, it is denied entry until

---

179 Paul Pheloung is the Program Manager at DAFF.

180 NWRAS Review Group, *Review of the National Weed Risk Assessment System* (30 November 2005) Weeds Australia, 31 <http://www.weeds.org.au/docs/Review_of_the_National_Weed_Risk_Assessmt_System_2005.pdf>.

181 Ibid 16.

182 Paul Pheloung, 'Use of the Weed Risk Assessment Tool in Australia's Approach to Pest Risk' in *Identification of Risks and Management of Invasive Alien Species Using the IPPC Framework*, Proceedings of the workshop on invasive alien species and the International Plant Protection Convention, Braunschweig, Germany, 22–26 September 2003. Rome, Italy, FAO <http://www.fao.org/docrep/008/y5968e/y5968e0l.htm>. .

183 For a discussion of the limitations of the WRA, see Caley, Lonsdale and Pheloung, above n 27, 279; for a discussion of uncertainty in a weed risk assessment model based on the WRA, see Benke, Steel and Weiss, 'Risk Assessment Models for Invasive Species: Uncertainty in Rankings from Multi-criteria Analysis', above n 29.

184 DAFF, above n 176, question 2.

185 Ibid question 4.05.

186 NWRAS Review Group, above n 180, 31; DAFF, above n 176, question 6.03.

187 NWRAS Review Group, above n 180, 31.

188 DAFF, above n 176.

189 NWRAS Review Group, above n 180, 31.

190 Ibid.

191 Ibid 19.

192 Ibid.

additional information is obtained.[193] This type of determination is sometimes referred to as placing a species onto a 'grey list'.

The WRA procedure does not subject the species to a full risk assessment, yet it can still identify risks and, importantly, areas where scientific evidence is lacking and/or uncertain. Indeed, the process guides decision-makers towards taking into account both the risk the species presents and also the quality of available scientific evidence.[194] The latter is significant because WRA processes potentially represent a way of bridging the divide between precaution, scientific certainty and risk.[195] First, by focussing on the extent and conclusiveness of scientific knowledge, the WRA can pinpoint whether it is plausible that a species will become invasive or a threat to biodiversity; secondly, the system can also trigger measures where there is so little evidence that it is not possible to identify whether the plant is likely to become a weed. In both cases the WRA prompts the implementation of precautionary measures, namely, refusing entry to the species until more information is obtained. In many respects, the WRA draws out commonalities between art 5.7 of the *SPSA* and the precautionary approach.

For example, both art 5.7 and the WRA contemplate remedial measures where the scientific evidence is insufficient in quantity. Although art 5.7 only permits temporary measures, this does not fly in the face of either the WRA or the precautionary approach. There is nothing in the formulation of either to indicate that precautionary measures should be permanent. If insufficiencies or uncertainties in the scientific evidence are removed, measures may be revised. Indeed, the *CBD Guiding Principles* emphasise the need for members to monitor and update their IAS regimes[196] and also to manage IAS in accordance with adaptive management practices recommended by the ecosystem approach.[197] In particular, the ecosystem approach encourages regulators to make small but incrementally significant management decisions that are monitored and refined.[198] Moreover, the notion of using a risk assessment process to identify uncertainty is not contrary to the precautionary approach and principles that underpin the *CBD*. As already noted, principle 1 of the *CBD Guiding Principles* specifies that measures should be 'based on the precautionary approach … with reference to risk analysis'.

---

193 Ibid 45.
194 Ibid 42.
195 Ibid 19.
196 *CBD Guiding Principles*, principle 5.
197 Ibid principle 3; the ecosystem approach was adopted by the Conference of the Parties of the Convention on Biological Diversity, *Report of the Fifth Meeting of the Conference of the Parties to the Convention on Biological Diversity Held in Nairobi 15–26 May 2000*, UN Doc UNEP/CBD/COP/5/23 (22 June 2000), 103 <http://www.cbd.int/doc/meetings/cop/cop-05/official/cop-05-23-en.pdf>. Adaptive management is exemplified in principles such as principles 5, 6 and 9 of the ecosystem approach. Although in part 4 of this article the author referred to the inadvisability of amassing copious amounts of inconclusive evidence, adaptive management practices do not operate in this manner. The changes to management, monitoring and refinement advanced by the ecosystem approach are carried out with the purpose of managing, rather than overcoming, uncertainty.
198 Cooney, above n 44, 31.

However, notwithstanding this common ground, the WRA has not been directly tested in the WTO. It is not certain, for example, whether the type of provisional importation ban imposed under the WRA accords with states' obligations pursuant to art 5.7 of the *SPSA*. To start with, states could have differing perceptions as to whether sufficient information has been provided to carry out a full risk assessment, which could lead to challenges in order to determine whether a species has been correctly categorised onto a 'grey list'.

Furthermore, art 5.7 does not define what is meant by a 'reasonable time'. The WTO Appellate Body has indicated that the concept of reasonableness should be determined on a case-by-case basis.[199] However, given that it is not uncommon for the invasive potential of a species to take up to 170 years to manifest,[200] the meaning of 'reasonable' presents an abundant source of conflict. One state might consider that two or three years is a reasonable time-frame for reassessing temporary measures,[201] while another state might consider a considerably longer time more reasonable.

In addition, a more basic concern is whether the WRA potentially conflicts with the underlying precepts of the risk assessment process as conceptualised by the *SPSA*. This is a particularly significant issue with regard to 'grey lists', where the scientific evidence used to create these lists is uncertain or inconclusive.

As discussed in part 4 above, in dealing with uncertainty, regulators balance avoiding two types of errors: type I errors that give false positive results and type II errors that give false negative results.[202] In the case of IAS, a false positive result wrongly indicates that a species will become invasive or cause environmental harm, while a false negative result erroneously concludes that a species will not become invasive or will not cause environmental harm. In scientific research the aim is to reduce type I errors, but commentators have questioned whether the same approach is appropriate to environmental regulation. In this case, the main purpose should be to reduce type II errors.[203] This concern is reflected in the development of the precautionary approach, which permits regulators to ward off type II errors.[204] It is a particularly important regulatory tool, where the consequences of a type II error are irreversible, such as the extinction of species. [205]

---

199 *Japan – Agricultural*, above n 103, [93].

200 Low, above n 37, 216–17.

201 See, eg, *Revised Draft Import Risk Analysis for Bananas from the Philippines 2005*, above n 126, [2.1]–[2.16] and the discussion on monitoring and the review of measures. Although Biosecurity Australia recommended a period of one year for monitoring, the Senate increased this to 10 years.

202 Daniel J McGarvey, 'Merging Precaution with Sound Science Under the Endangered Species Act' (2007) 57(1) *Bioscience* 65, 65.

203 Ibid 65; in the context of type I errors and the null hypothesis, see David R Anderson, Kenneth P Burnham and William L Thompson, 'Null Hypothesis Testing: Problems, Prevalence and an Alternative' (2000) 64 *Journal of Wildlife Management* 912, 912, 915.

204 McGarvey, above n 202, 65.

205 Ibid.

The initial determination by regulators, whether they wish to avoid type I or type II errors, shapes the choice of the supporting hypothesis that instigates the decision-making process. The supporting hypothesis, called the 'null hypothesis', is the hypothesis being tested and it stands unless rejected or disproved by scientific evidence.[206]

With respect to IAS, the choice of a null hypothesis to avoid type I errors would be expounded in terms of alien species *not* being invasive. Accordingly, where scientific evidence is incomplete or inconclusive, it is unlikely that the null hypothesis will be disproved, thus allowing species entry. This would be the case even though scientists have pointed out that a 'failure to reject the null hypothesis' does not prove the hypothesis.[207] Yet where the evidence is sparse or inconclusive, the danger is that the outcome will lead to a type II error.[208] The manner in which art 5.7 of the *SPSA* operates is a case in point. It is an approach designed to reduce type I errors, especially those that can hinder international trade. By way of contrast, in its practical operation, the WRA is predicated on avoiding type II errors (false negatives).

This is akin to 'equivalence testing', a process which reformulates the null hypothesis so that the unwanted outcome becomes the new starting point.[209] In the case of IAS, the null hypothesis would rest on a presumption that the species in question *is* invasive. Where the information is not conclusive, regulators can employ notions of plausibility, as proposed by Simberloff,[210] to determine a level of threat to biodiversity and use this knowledge to prevent entry of species until further information is obtained.

Although driven by science, the WRA process is nevertheless contentious because it also accommodates an information-based evaluation of the evidence. It has, for example, engendered a degree of criticism in Australia. In a review of the WRA in 2005, stakeholders censured the 'potential for false positives' and the 'number of species scoring as "further evaluate"'.[211] This type of criticism demonstrates concern over whether WRA processes are fully consistent with art 5.7 of the *SPSA*.

VIII Conclusion

The problem of uncertainty in IAS regulation can be viewed from different perspectives, depending on whether the problem is seen through the lens of international environmental law or international trade law. Where the problem

---

206 A technical definition construes the null hypothesis as 'the hypothesis that there is no validity to the specific claim that two variations (treatments) of the same thing can be distinguished by a specific procedure': Sybil P Parker (ed), *McGraw-Hill Dictionary of Scientific and Technical Terms* (McGraw-Hill, 2003).

207 Philip M Dixon and Joseph H K Penchmann, 'A Statistical Test to Show Negligible Trend' (2005) 86(7) *Ecology* 1751.

208 McGarvey, above n 202, 65.

209 Ibid 68.

210 Simberloff, above n 27, 256.

211 NWRAS Review Group, above n 180, 42.

can be framed in different ways, the literature highlights the benefits of taking a 'relational approach' to uncertainty. This means that regulators should address uncertainty from the perspective of all stakeholders, rather than solely from one standpoint.

Yet regulators dealing with IAS must reconcile the strategies of two international regimes that evince sufficient differences to make taking a relational approach to uncertainty problematic. At the heart of the dilemma lie difficulties in identifying the threshold of harm or potential harm that can trigger the application of measures. The precautionary approach indicates that uncertainty should not be a bar to implementing measures in order to prevent serious environmental harm; while notions of scientific certainty require measures to be underpinned by a sufficient volume of conclusive scientific evidence.

One promising means of drawing these two concepts together lies in the use of a risk assessment, such as Australia's WRA. This process can identify potentially invasive species stemming from gaps in knowledge or inconclusive evidence. In the latter case, the evaluation provides a method of establishing 'plausible hypotheses' that can prevent entry of species until further information is obtained. The process still requires a level of scientific evidence to demonstrate a risk to the environment. However, once that level of evidence is attained, the implementation of preventative measures proceeds notwithstanding lack of full scientific certainty. The alternative, in accordance with WTO systems, is to channel inconclusive evidence into a full risk assessment, where the very lack of scientific certainty leads to measures being declared invalid.

Ultimately, the manner in which uncertainty is managed needs to be re-evaluated at an international level. Taking a relational approach to uncertainty would mean that IAS are viewed as a trade *and* environment problem rather than a trade *or* environment problem. This would encourage regulators to find resourceful solutions that that take into account the needs of stakeholders from every relevant regime.